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ABSTRACT

Reported is a study in which the effectiveness of an adapted surfing apparatus was evaluated for eight adolescents with upper extremity physical impairments. Related literature is reviewed, and a detailed analysis of the adapted device is presented. Case studies of the individual Ss are provided to demonstrate test performance in a pool and the ocean. Findings are said to confirm that the apparatus is safe, versatile in its adaptability to various disabilities, and useful for rehabilitation and recreation. (CL)

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ED115033

AN ADAPTIVE SURFING APPARATUS

A PROJECT

Presented to the Department of Physical Education

California State University, Long Beach

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

By Gregory Bond

January 1975

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AN ADAPTIVE SURFING APPARATUS

By

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ABSTRACT

AN ADAPTIVE SURFING APPARATUS

By

Gregory Bond

January 1975

The purpose of this project was to design, construct and evaluate an adaptive surfing apparatus to be used by a variety of handicapped individuals with upper extremity involvement. The effectiveness of the apparatus was evaluated from a functional standpoint in both a swimming pool and the ocean.

Eight handicapped individuals served as subjects. Their disabilities included cerebral palsy, spasticity, birth defects, polio, amputation, and loss of prehension. All eight subjects were tested in a pool. Three subjects completed an ocean check-out. One subject used a prosthesis in conjunction with the apparatus.

The test results substantiated the effectiveness of the apparatus under test conditions. The apparatus was found safe, versatile in terms of adaptability to various disabilities, and effective particularly when the operator had previous water experience. The test results indicated that the adaptive surfing apparatus can be used by selected handicapped operators for rehabilitation and recreation.

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Chapter 1

INTRODUCTION

During the last two decades, thousands of young people have flocked to our beaches to take part in one of the most exciting sports known to modern man. Surfing requires judgment, balance, grace, and stamina. It demands that its participants be fit, well versed in the art of swimming, and able to contend with nature in her uncompromising domain. Finally, it holds a fascination for those of us with a love for the sea and a thirst for adventure.

People working in the field of adaptive physical education are constantly searching for inherently motivating activities. This quest has given birth to the "special Olympics," wheel-chair bowling, hiking for the blind, amputee skiing, and myriads of other sports modifications. (6:49). The handicapped may now enjoy a well-rounded, thoroughly comprehensive program of physical activities which once appeared beyond their grasp. They may now engage and succeed in recreational pursuits which the fit find challenging. They may now achieve a certain degree of physical equality regardless of their infirmity.

"Rehabilitation, almost by definition, means

involvement. Any therapeutic activity, if it is to succeed, must motivate the individual to participate." (2:65). This statement has been the motto for a variety of rehabilitative programs for the handicapped. "Involvement" and "motivation" are essential in rehabilitation because the disabled individual is at odds with himself and his environment. He must have the proper impetus in order to contend with the unique set of circumstances affecting his life. Therefore, the successful rehabilitative program will include activities which are a source of enthusiasm and interest.

Countless possibilities for rehabilitation exist in the extensive realm known as adaptive physical education. Aquatic therapy is one area with particular effectiveness. The aquatic sports utilize a medium in which the handicapped can move supposedly useless muscles with amazing ease. Non-ambulatory people can enjoy a certain degree of mobility in the water which they could not experience on land. Although there are innumerable advantages to the aquatic environment, a primary consideration from the rehabilitative standpoint is its ability to promote relaxation and sustain interest. Past rehabilitative swimming programs have made excellent use of their media; however, they have yet to explore all the aspects of aquatic therapy. There is one

"unexplored area" which combines rehabilitation and recreation. Surfing is challenging, relatively safe, and provides an opportunity for individual development.

STATEMENT OF THE PROBLEM

The purpose of this project was to design and construct an adaptive surfing apparatus and validate its effectiveness from a functional standpoint for handicapped individuals with upper extremity involvement.

IMPORTANCE OF THIS STUDY

Surfing would be an excellent activity for rehabilitating the handicapped. Naturally, not every handicapped person could learn to surf; however, a great many could take advantage of this tremendously popular sport. Certain modifications of the traditional surfing apparatus can be made which would allow many disabled individuals to experience the thrill of riding waves shoreward. The primary intention was to propose the design for a surfing apparatus which might be used by people with upper body limitations, yet who still have full use of their lower extremities. This would include various types of amputees, paraplegics, people with birth defects, and some individuals with chronic or congenital musculoskeletal impairments. A prerequisite for anyone

using this surfing device would be the ability to maintain a state of buoyancy in the event that he was separated from his apparatus. Therefore, the number of individuals capable of utilization would be limited by the type of disability, previous exposure to swimming, and potential ability to learn to swim.

A lengthy justification for an adaptive surfing apparatus is both unnecessary and inappropriate. The possibility of involving just one handicapped individual in an invigorating physical activity is reason enough for its construction. Ideally, many people will be able to take advantage of such an instrument, yet an attempt to estimate the number of operators is beyond the scope of this project. Therefore, no attempt will be made at speculation or a philosophic discussion on the merits of surfing as a therapeutic modality. The primary points of emphasis will be the practicality of the surfing apparatus, the safety aspects, its actual construction and design, and its implementation and utilization.

LIMITATIONS

Related research concerning bellyboards for the handicapped is virtually non-existent since it is a relatively unique area. The lack of contributory information is certainly no reason to abandon the topic.

This minor limitation merely serves as incentive for some original work in a thoroughly interesting area.

ORGANIZATION OF REMAINING CHAPTERS

The remaining pages of this thesis follow traditional format. The chapter entitled "Review of Related Literature" is followed by Chapter 3, dealing with the testing procedure. Chapter 3 begins with an explanatory note and a detailed description of the apparatus design. The apparatus design is further supplemented by a description of the apparatus and its use in conjunction with a prosthesis. The testing program is then examined in more detail. An enumeration of the eight case studies which served as verification for the successful operation of the apparatus appears in Chapter 4. These pages are completed by a summary chapter, which includes a conclusion and several recommendations.

Although three illustrations of the adaptive surfing apparatus have been provided in the appendix, a comprehensive slide presentation, illustrating the apparatus and portions of the testing program, accompanies this thesis.

Chapter 2

REVIEW OF RELATED LITERATURE

The last few years are witness to an influx of literature relating to adaptive physical education. In spite of this great literary abundance, apparently nothing has been published which directly describes or suggests an adaptive surfing device.

Many attempts are being made to project new dimensions for surfing. James E. Odenkirk, associate professor at Arizona State University, has developed the guidelines for a surfing course to be offered to college students at the world's first authentic inland surfing facility. Several west coast colleges and universities already offer surfing as part of their physical education program. (5:26). In fact, the popularity of surfing has led to the institution of the Western Intercollegiate Surfing Council. This organization sponsors surfing competition at the college level and promotes a wide variety of recreationally oriented surfing activities in over fifteen junior colleges, colleges, and universities throughout the nation. (5:27). This interest in collegiate surfing reinforces the concept that an organized instructional program for surfing can exist

within the curriculum. It also suggests the possibility of initiating a remedial surfing class to supplement a regular surfing class just as adaptive physical education classes supplement the regular physical education program.

Now, let us consider the field of rehabilitative therapy in general.

The proponents of aquatic therapy as a form of rehabilitation suggest that swimming and water activities are inherently motivating and therapeutically sound from a developmental standpoint. Frances Grove and Yvonne Weber are two individuals involved in an aquatic therapy program at Pacific State Hospital in Pomona, California. They have found that aquatic therapy offers to nearly every handicapped person an excellent rehabilitative medium. Their program includes the non-ambulatory and severely retarded person as well as others with more general physical handicaps. (2:65).

Other researchers in Washington, D.C., are working with movement exploration in the swimming pool. They have found that the aquatic medium is advantageous in teaching self image, basic locomotor movements, space-force relationships, and factors such as buoyancy, balance, and underwater breath control. (1:65).

These researchers substantiate the viewpoint that aquatics provide the handicapped with excellent

recreational, developmental, and rehabilitative opportunities.

Another recreational sport has contributed to the rehabilitation of the handicapped. This sport is snow skiing. Skiing is similar to surfing in as much as it takes place in a natural environment, necessitates the use of a special propelling device, and involves weight shift and transfer in order to manipulate the special equipment. Skiing is mentioned at this point because an adaptive surfing apparatus might contribute to the rehabilitation of the handicapped in much the same way as modified skiing devices already in existence. The National Amputee Skiers Association continually encourages amputees and post-polio victims to learn how to ski. Obviously, certain modifications are necessary. Books describing equipment, techniques, and modes of instruction are made available to anyone interested in the program. An elaborate framework of introduction, education, and instruction has been implemented in order to insure the success of the handicapped. The success of the program itself is illustrative of the fact that various types of disabled persons can participate in rigorous activities with the aid of specially designed equipment. The work of the National Amputee Skiers Association has definite merit when considering the

practicality of a surfing device for amputees and post-polio victims. (7:72).

SUMMARY

The scarcity of research relating to an adaptive surfing apparatus is the main limiting factor to the coherency of this chapter. However, research involving aquatics therapy does substantiate the viewpoint that the aquatic medium can provide the handicapped with excellent recreational, developmental, and rehabilitative opportunities. Furthermore, the success of a recreational and rehabilitative program such as the one sponsored by the National Amputee Skiers Association reinforces speculation concerning the practicality of an adaptive surfing apparatus.

Chapter 3

PROCEDURES

This chapter is descriptive in nature and deals with three important phases of the project.

First, the possible modifications of an adaptive surfing apparatus are explained and related to the actual apparatus design. Next, a foundation is established for the use of the apparatus in conjunction with a prosthetic appliance. Finally, the criteria for operation, and a description of the subjects and the test program appear.

The adaptive surfing apparatus is clarified in Chapter 3 in terms of design, construction, use, and test validation.

MODIFICATION CONSIDERATIONS

There are as many possible modifications of a surfing apparatus as there are types of physical disabilities. The test apparatus described in this chapter was designed to accommodate a wide variety of handicapped individuals with limited use of their upper extremities, yet "functional" use of their lower extremities.

A few words of explanation are necessary before entering upon a description of an adaptive surfing

apparatus. Any apparatus for the handicapped must have highly individualized modifications. Specific dimensions cannot be cited because no one set of dimensions can apply to every type of handicap or handicapped individual. A general statement may be made with regard to the approximate dimensions of the apparatus; however, it is vital that one realize these dimensions are only approximations. The size and length of the apparatus are dependent upon the size and weight of the operator and various flotation factors. The contour, depth, and length of the concave surface grooves is also relative, being determined by the size, length, and shape of the operator's limb. The placement of the special restraining straps is dictated by the type of disability as well as the length of the limb. Straps may be shifted forward or backward on the apparatus in order to facilitate proper attachment, body position, and balance.

All these accommodations and modifications are possible because of the nature of modern surfboard construction. Most modern surfing devices have an inner core made of high density polyurethene foam, which is covered by several layers of fiberglass and resin. This foam core can be molded into any shape imaginable by an experienced designer. Grooves, slits, and special attachments can be constructed with relative ease.

Although this can become a costly process, it is essential in individualizing the apparatus. The adaptability of the modern surfing device makes it an ideal instrument for meeting the individual needs of the handicapped.

APPARATUS DESIGN

The adaptive surfing apparatus, described in the following pages, was a modification of the conventional bellyboard. The conventional bellyboard is a device which is propelled through the water in the same way that a swimmer propels a kickboard across a pool. The major difference between a kickboard and a bellyboard is that the bellyboard is designed specifically for riding waves in the ocean. Consequently, it is shaped or contoured in order to facilitate wave riding. Fins are attached to the bottom of the bellyboard for the purpose of allowing the bellyboard operator to make directional changes and still maintain a favorable position within the shorebound wave. These directional changes can be accomplished by subtle weight shifts on the part of the bellyboard operator, herein referred to as the bellyboarder. Once again, weight transfer is the key to successfully maintaining the correct position within the wave.

The adaptive surfing apparatus is a modification of the conventional bellyboard. The major modification involved the point of attachment for the handicapped individual as well as special deck and buoyancy adaptations. Securing straps were built into the top surface of the board. These straps were made of a waterproof fiber called Velcro, which the bellyboarder locked into place by means of his teeth. The operator slipped his arms into one concave surface groove at a time, grasped one end of the strap in his teeth, and gently overlapped each end over his extremity. He repeated the process for the other groove and pressed the overlapped straps into place with his face. The Velcro straps possessed a self-locking quality which withstood the tremendous compressive force of breaking waves. The main advantage to using Velcro was the ease with which the straps were removed when desired. The operator simply grasped one end of the strap in his teeth and pulled in a direction parallel to the surface of the bellyboard. This motion immediately released the bellyboarder's limbs.

Another feature of this apparatus was the two rope handles which were positioned above each of the concave surface grooves. These rope handles were grasped by the bellyboarder in the event that he had either one or both of his hands. However, if this was not the case,

the Velcro straps served as adequate attachments. An operator without hands kept his limbs secure in two ways: (1) he tightened the straps in order to achieve a more favorable fit and (2) he abducted or adducted his limbs and thus increased the tension of the Velcro straps. The abduction and/or adduction was naturally accompanied by a weight transfer, which influenced the direction of the bellyboard within the wave. Therefore, the course of the bellyboard was primarily determined by the operator's body movements.

The actual size of the apparatus used in the test study was forty-five inches long, twenty-five inches wide at its widest point, and four inches thick. The apparatus is illustrated in Figure 1, Appendix A.

THE APPARATUS AND A PROSTHESIS

So many advances in prosthetic appliances have taken place in the last few years that it is difficult to select any one device which would work best with the adaptive surfing apparatus. (3:v). Needless to say, an examination and evaluation of each individual appliance would prove tedious and somewhat repetitious. However, there are three basic requirements for a prosthesis to be used in conjunction with the adaptive surfing apparatus. The first consideration is prehension, or the ability to

grasp objects, although this is not the primary requirement since a long stump could be attached quite securely to the apparatus. The second consideration is mobility at the wrist, elbow, and shoulder joints. The final consideration involves the durability of the prosthesis, especially in terms of being waterproof and resilient.

The problem of prehension is easily remedied through the use of any one of a variety of terminal devices. Pneumatic hands, Dorrance hooks, and three fingered hands are all available to the amputee. These terminal devices are exchangeable in a matter of seconds. (3:92).

Joint mobility in the wrist, elbow, and shoulder is achieved through a number of "standard prostheses," which are hinged to facilitate the various movements of the arm and shoulder. Here, the mechanical pivots or hinge joints are common. (4:77). The major limiting factor in current prosthetic design is not in the appliance. The patient's inability to learn its most efficient use is more of a problem than the construction of a thoroughly mobile prosthesis. This predisposes the necessity for emphasizing prosthetic training as opposed to prosthesis construction and fabrication.

The durability of a prosthesis to be used in the water is no longer as formidable a problem as it once was. Wood and leather are now only two of many materials

commonly used in the construction of prostheses. (3:23). Polyester resin, plastic laminate, synthetic fiber material, Duralumin, polyurethane, and rubber are currently in widespread use. (4:79). These materials minimize the difficulty which the corrosive quality of salt water produces.

The accompanying illustrations (Appendix A) should aid the reader in visualizing the adaptability of the surfing apparatus in terms of prosthetic supplementation.

This is just one example of the manner in which a prosthetic appliance might be used. The only limit to other possibilities is the limits of one's imagination.

CRITERIA FOR OPERATION

The operator must have enough use of his legs so as to allow him to propel himself through the water while his arms remain attached to the apparatus. His legs, or lower extremities, must be "functional" to the point of allowing him to sustain a prolonged kick while floating half-atop the surfing apparatus. Certain amputees, post-polio victims, cerebral palsy cases, paraplegics, and individuals with musculoskeletal disorders could take advantage of the surfing apparatus. The ability to grasp objects is not a prerequisite to successful operation. The major consideration is that some portion of the

prospective operator's upper extremities be inserted into the concave grooves on the surface of the apparatus and strapped into place. The ideal point of attachment is beyond the elbow joint on the radius or ulna. It is not essential that the operator have hands, nor is it important that he have full muscular control in his arms. Overlapping straps with a special quick release device secures the person's extremities and allows him to maintain contact without any extraordinary effort.

SUBJECTS

Eight handicapped individuals with varied disabilities and backgrounds served as test subjects. All disabilities involved one or both upper extremities. Three cerebral palsied individuals from Carl Harvey School in Santa Ana, California volunteered. Three other subjects were referred by the Child Amputee Project at the University of California, Los Angeles. The remaining volunteers were residents of Orange County and attended public schools. Several individuals had involvement in both their arms and legs. The subjects' disabilities were categorized as follows: three male adolescents with varying degrees of cerebral palsy and spasticity; one twelve-year-old male with a unilateral birth defect; a male amputee without a prosthesis; a female amputee

with a prosthesis; a post-polio victim with mild involvement to his entire right side; and a sixteen-year-old with a cast eliminating wrist flexion and impairing prehension.

The criteria for participation in the testing program were that the individual must have a disability which allowed him to achieve satisfactory attachment to the adaptive surfing apparatus and maintain a balanced position while under water. This meant the individual had two "workable" attachments whether they were mechanical, prosthetic, or one normal and one abnormal due to injury. The ideal operator should also be familiar with the ocean; that is, it was preferable he have previous bodysurfing, bellyboarding, or surfing experience. Finally, a qualified therapist and/or physician should determine that the individual is pool-safe and able to withstand the rigors of testing.

TESTING PROCEDURE

A complete description of the testing and training program criteria follows.

All subjects were tested in swimming pools after an initial orientation procedure. Three subjects were tested in the ocean and the pool. These three individuals were selected for ocean testing after meeting two

preliminary requirements. First, they were required to demonstrate swimming proficiency to the satisfaction of the test administrator. Second, they must have had previous ocean swimming experience. Swimming proficiency in both the pool and ocean was evaluated subjectively prior to each testing session.

Five non-swimmers or poor swimmers could be tested safely in the controlled environment of the pool; however, no attempt was made to test these individuals regardless of their success using the apparatus during pool testing.

Statement of the Test Problem

The purpose of the test study was to substantiate the effectiveness of the adapted surfing apparatus for the handicapped from a functional standpoint in both a swimming pool and the ocean.

The Testing Program

The testing program consisted of three phases. The first phase involved the initial introduction to the apparatus and a dry land demonstration of the attachment of the device. Pool instruction followed and was culminated by a pool check-out. The pool check-out preceded the final phase of testing. This phase was the surf check-out and ultimately validated the operator's

complete mastery of the apparatus.

Pool check-out. At this point it was assumed that the individual was pool safe. To qualify for the surf check-out, the operator was required to:

1. Demonstrate full control of the attachment devices from the standpoint of securing and releasing himself.

2. Propel the board a distance of one hundred meters via a conventional swimming kick such as the flutter kick, the dolphin kick, or the frog kick. The operators used swim fins in conjunction with the apparatus due to the additional power they supplied.

3. Turn and initiate directional changes to the left, the right, and 360 degrees in either direction.

4. Right the apparatus and maintain control in the event it was overturned. The criterion was that the operator be able to go from an inverted position to the right-side-up position and stay in control of the surfing device.

Surf check-out. This test phase was similar to the pool check-out. The primary difference was that the surf check-out took place in the ocean and the operator contended with current and waves. Naturally, this check-out was well supervised and the individual had received ample preliminary instruction. The objective of the surf

check-out was to determine the operator's ability to catch and ride shorebound swells. His maneuverability and wave riding proficiency were evaluated on the basis of control and the successful completion of several rides. At this point, the opinion of an experienced surfer or a knowledgeable observer, as well as the operator's own testimony provided the supplementary information necessary for determining the success of the surf check-out.

Chapter 4

RESULTS

Eight individual case studies appear in this chapter. Each subject has been described in terms of age, sex, disability, and test performance. The chapter concludes with a summary of the case studies and several test findings.

SUBJECT ONE

Age: 19

Sex: male

Disability: moderate to severe cerebral palsy predominant on entire left side of body markedly affecting gait, balance, posture, laterality, and breath control.

Observations: Subject One found it difficult to walk to the pool unassisted. His balance and breath control was such that he was unable to right the apparatus without assistance after being instructed to capsize it. However, he was able to attach and disengage the straps unaided, and sustain a modified flutter kick over a reasonable distance. He was unable to duplicate this kicking motion without the use of the apparatus. The

range of movement in his legs was substantially increased when supported by the apparatus. The surf check-out was inadvisable due to the severity of the subject's disability.

SUBJECT TWO

Age: 19

Sex: male

Disability: moderate cerebral palsy affecting all extremities. The subject made use of a wheelchair, but walked with the aid of a cane.

Observations: Subject Two successfully operated the apparatus during all phases of the pool check-out with the exception of the righting procedure. It was necessary for him to push off the bottom of the pool in accomplishing the righting task. Subject Two increased the range of his leg movement far beyond that normally associated with his disability, while using the apparatus. The subject's pool swimming ability and unfamiliarity with ocean conditions made the surf check-out inadvisable.

SUBJECT THREE

Age: 15

Sex: male

Disability: moderate cerebral palsy affecting

all extremities.

Observations: Subject Three was extremely apprehensive about any water activity during the initial stages of testing. He was classified as a non-swimmer. The subject was eventually able to attach and disengage the apparatus as well as sustain a flutter kick without his previous fear of sinking. Nevertheless, the surf check-out was inadvisable due to the subject's inexperience.

SUBJECT FOUR

Age: 12

Sex: male

Disability: unilateral birth defect. The subject had only a small portion of stump extending beyond his elbow joint. Prehension in the disabled extremity was impossible except for a "grasping" capability of securing objects between his stump and bicep.

Observations: Subject Four was another apprehensive non-swimmer who eventually overcame his initial fears. He successfully operated the apparatus in all phases of the pool test with the exception of the righting procedure. Once again, the subject's inexperience with the ocean and lack of swimming ability made the surf check-out inadvisable.

SUBJECT FIVE

Age: 12

Sex: male

Disability: unilateral amputee without a prosthesis who possessed approximately three inches of stump beyond the elbow joint.

Observations: the subject completed all phases of pool testing with maximum success. He was particularly adept at the righting procedure, which he accomplished with minimal instruction. The subject was unable to participate in the surf check-out due to a time conflict.

SUBJECT SIX

Age: 16

Sex: male

Disability: cast covering the right forearm and hand. The cast eliminated wrist flexion and impaired prehension. The disability was diagnosed as a navicular fracture.

Observations: the subject successfully completed all phases of the pool check-out and the surf check-out with no difficulty. The special straps eliminated the need for bilateral prehension.

SUBJECT SEVEN

Age: 21

Sex: male

Disability: polio victim with mild involvement of the entire right side causing no major postural problems, but having a slight effect on prehension and gait.

Observations: the subject completed all phases of both the tests without difficulty. During the surf check-out the waves measured approximately four to six feet. In spite of the size of the surf and the subject's prehension problem, the subject maneuvered the apparatus without difficulty.

SUBJECT EIGHT

Age: 17

Sex: female

Disability: unilateral amputee using a prosthesis equipped with a grasping device on its terminal end.

Observation: the subject successfully completed all phases of the pool check-out and the surf check-out. The subject operated both the apparatus and her prosthesis with relative ease. She was extremely proficient in maneuvering the apparatus through the surf in spite of being a beginning wave rider.

SUMMARY OF CASE STUDIES

All eight subjects were able to attach and disengage the special Velcro straps without difficulty. Five subjects were able to propel themselves and the apparatus the required distance, negotiate the proper turns and maneuvers, and satisfy all the requirements of the pool test. The three subjects who encountered difficulty were limited by their particular disability rather than any limitation of the apparatus. It is noteworthy that all three boys demonstrated movement patterns while attached to the apparatus, which they were incapable of exhibiting on land. All three subjects exhibited an obvious enthusiasm and interest in the testing procedure, although they could easily be called "apprehensive non-swimmers" prior to testing.

The three subjects who tested in both the ocean and the pool met all testing requirements. The female amputee with the prosthesis became especially proficient on the apparatus. All three subjects were impressed with the effectiveness of the surfing apparatus in the ocean.

FINDINGS

The findings which follow were formulated as a result of the test program.

1. The adapted surfing apparatus utilized in

this study is a safe and effective wave riding device for a variety of handicapped persons, including cerebral palsied, polio victims, people with birth defects, and amputees.

2. The adapted surfing apparatus utilized in this study has value in pool use as a rehabilitative device for the handicapped.

3. Certain types of prosthetic appliances can be used in conjunction with an adapted surfing apparatus.

4. The adapted surfing apparatus is particularly effective when the operator has had previous water experience.

Chapter 5

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

SUMMARY

This study was initiated to suggest a design for an adaptive surfing apparatus, which could be used by a variety of handicapped individuals with upper extremity involvement. A test study was also implemented to evaluate the effectiveness of the apparatus from a functional standpoint in both a swimming pool and the ocean.

The results of the testing program substantiated the effectiveness of the adaptive surfing apparatus design under test conditions. The apparatus was also found to be safe when properly used, and versatile in terms of adaptability to a variety of disabilities. The test results seemed to indicate that the adaptive surfing apparatus can be used by selected handicapped operators to foster recreation, rehabilitation, and physical fitness.

CONCLUSION

On the basis of the testing program conducted in

this study, the adaptive surfing apparatus was an effective design for a variety of handicapped individuals with upper extremity involvement.

RECOMMENDATIONS

While the results of this study seemed to indicate that the adaptive surfing apparatus was an effective surfing vehicle for a variety of handicapped individuals, the extent to which this device can be used has yet to be fully determined. Lower extremity amputees, above-elbow amputees, severely disabled polio victims, and many other handicapped types could conceivably use the apparatus.

The use of the adapted surfing apparatus in promoting fitness and serving as a vehicle for rehabilitation has many ramifications which might also be investigated.

The psychological implications of success in a highly individual sport like surfing merits subsequent investigation.

These and myriads of additional considerations deserve attention in the way of additional research.

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APPENDIX A

FIGURES

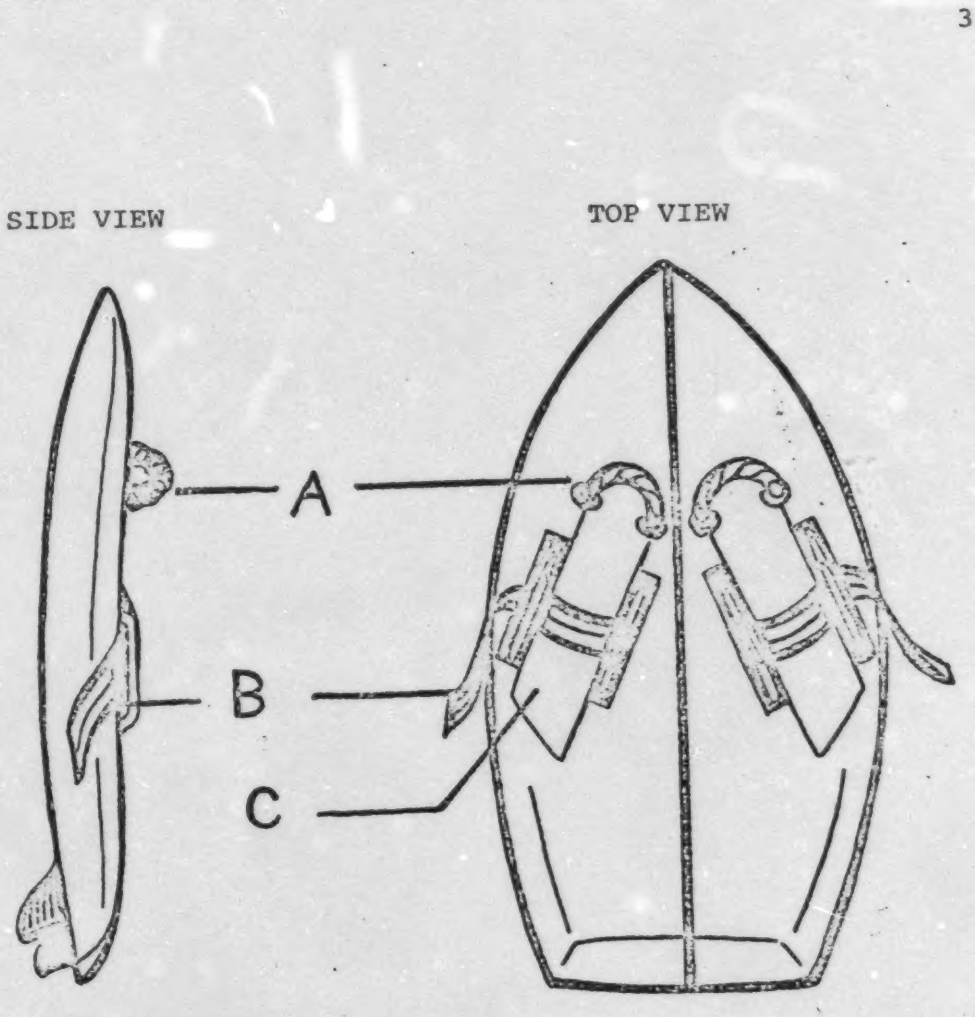

Figure 1. Two Views of an Adaptive Surfing Apparatus. The upper case letter A denotes the rope handles in each view. B represents the special Velcro attachment straps. C points to one of the two concave surface grooves, represented by the parallel lines running diagonally below the rope handles.

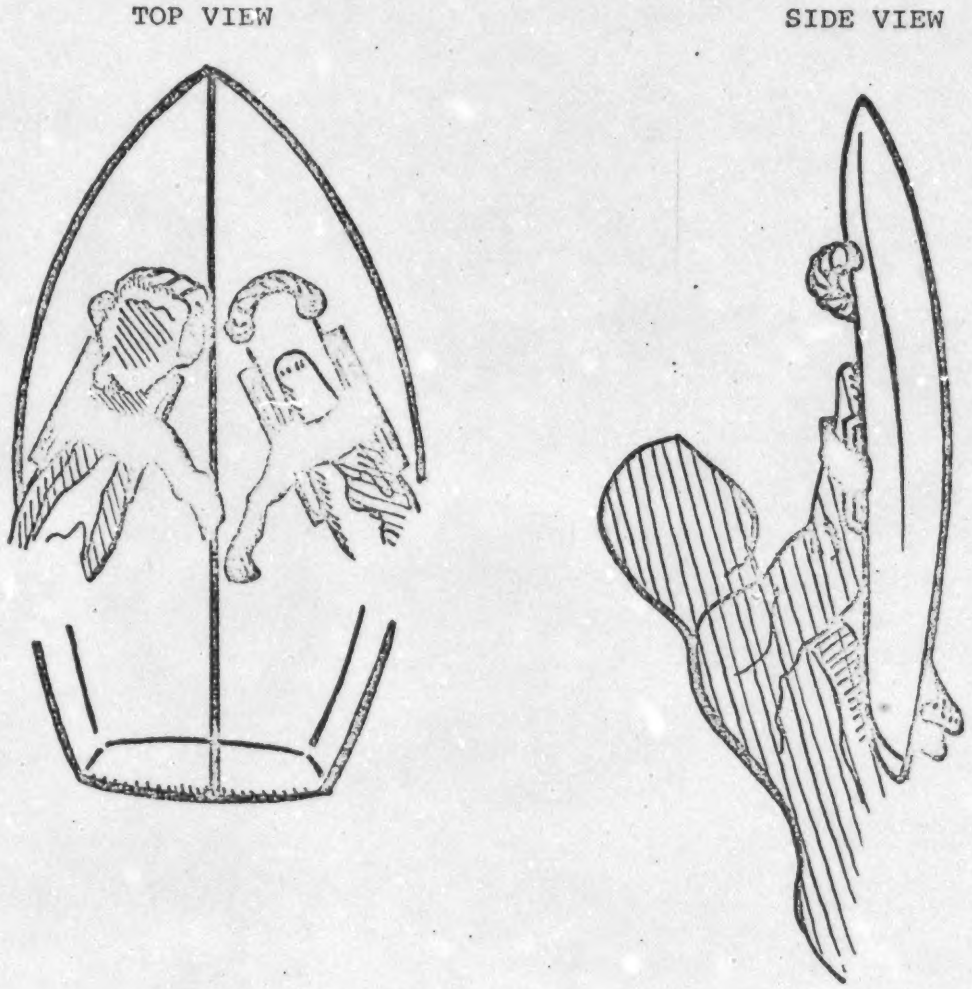

Figure 2. Two Views of an Adaptive Surfing Apparatus Showing the Placement of Limbs, the Attachment of the Velcro Straps, and Proper Body Position. The bellyboard operator in the illustration is an amputee without a right hand. His right limb is secured by means of the Velcro strap, while his left limb has the additional security of the rope handle.

TOP VIEW

SIDE VIEW

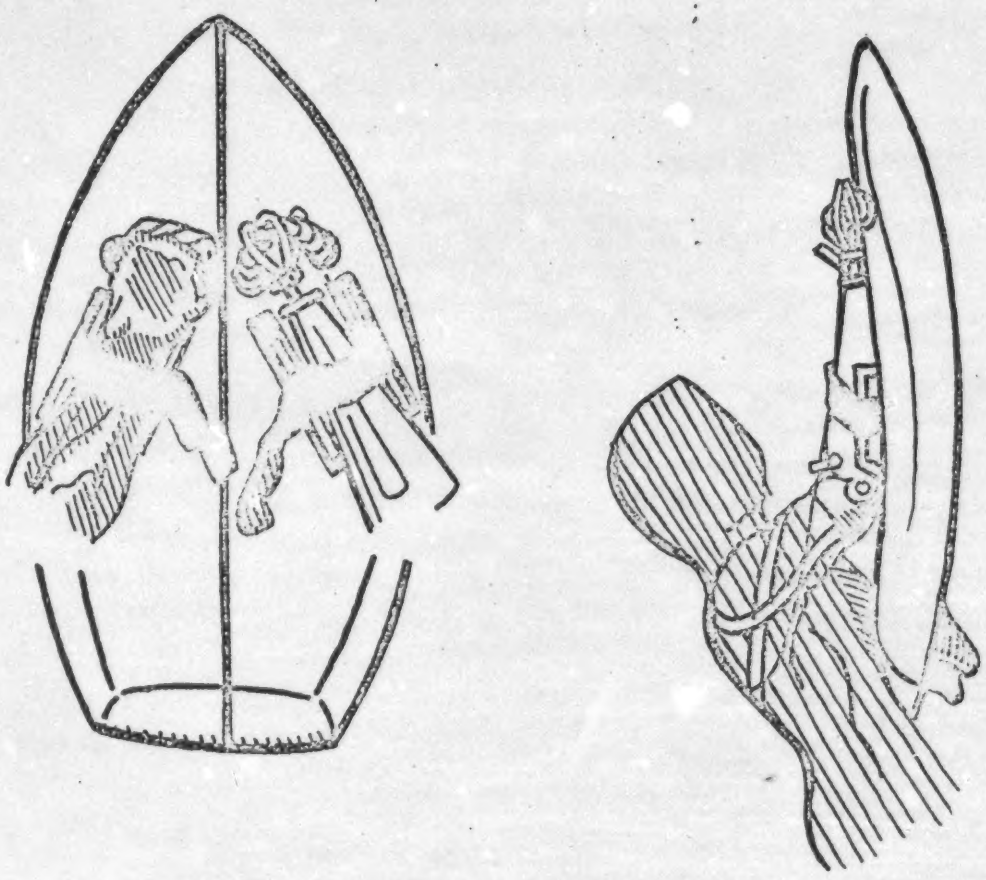

Figure 3. Two Views of an Adaptive Surfing Apparatus Showing a Unilateral Amputee With a "Standard" Above-Elbow Prosthesis. The terminal device pictured has three finger-like projections which closely approximate the pinching action of a crab claw when grasping the rope handle.

APPENDIX B

LIST OF SLIDES

1. Top view of an adaptive surfing apparatus
2. View of concave grooves, securing straps, and rope handles
3. Side view of grooves and securing straps
4. Top view of apparatus with straps secured
5. Female unilateral amputee with a prosthesis holding apparatus pool-side
6. Subject inserting prosthesis into groove
7. Subject securing strap with teeth
8. Subject completely secured and holding apparatus aloft
9. Side view of subject propelling the apparatus via a flutter kick
10. Front view of subject flutter kicking
11. Subject beginning to capsize apparatus
12. Second view of capsize maneuver
13. Subject completely submerged beneath apparatus
14. Subject righting apparatus
15. Second view of righting maneuver
16. Subject flutter kicking
17. Female unilateral amputee with a prosthesis holding apparatus on the beach
18. Subject carrying apparatus into ocean

19. Subject propelling apparatus out through the surf
20. Subject dropping into an unbroken wave
21. Subject riding a wave
22. Subject riding a broken wave